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A. Summary of Technical Activities

A.1. Euro-Link Network Status and Institutions

A.1.a. CERN

CERN's Olivier Martin and Paolo Moroni are working with Ameritech on their 45Mb to 155Mb OC-3/STM-1 upgrade, scheduled for completion December 1. However, because of personnel changes at Ameritech, a UIC subcontract to Ameritech enabling payment of local loop charges for the past year has not yet been approved, threatening installation delays. The Ameritech STAR TAP account manager, Tony Haeuser is expediting the subcontract approval and is proceeding with CERN's installation.

A.1.b. IUCC

A US State Department warning to American citizens advising against travel to Israel due to regional tensions caused Jason Leigh, Greg Dawe and Michael Lewis to cancel plans to attend Telecom 2000, November 6-9 in Tel Aviv. Telecom 2000 is Israel's largest annual telecommunications conference.

EVL's ImmersaDesk, however, was shipped and received by Technion University engineers, who set it up. With real-time remote training using a Polycom system, they were able to conduct a tele-collaborative session with EVL staff on November 5. EVL researchers used their CAVERNsoft-based applications to remotely debug ImmersaDesk hardware. (The ImmersaDesk tracker connected to the wand – the 3D input device – was not behaving correctly, but the Israelis didn't know how to explain the problem, never having worked with a wand and VR system before. By watching the erratic movements of the Israeli avatar's hand in the CAVE, Leigh, Dawe and EVL students were able to debug the problem.) A real-time collaboration between Israel, EVL in Chicago, SARA in Amsterdam and the Alliance booth at SC00 in Dallas, Texas, took place November 8-9.

STAR TAP Router outages and IUCC's changeover from satellite to terrestrial T3 links caused connectivity and multicast peering interruptions. Total downtime for November: 80 hours, 39 minutes.

A.1.c. NORDUnet

NORDUnet's original plan to terminate its service to STAR TAP in January 2001 and take advantage of the Internet2/Abilene ITN service has been changed. The connection to STAR TAP will be maintained, as NORDUnet wants access to other US federal agency networks (to which Abilene will not carry transit traffic) and UIC will continue to assume the cost of NORDUnet's local loop.

Further discussions with Abilene have made NORDUnet consider its connection to US and international research networks to be only via STAR TAP after July 1, 2001. The initial capacity into STAR TAP would be 622Mb.

A.1.d. Renater2

France Telecom recently upgraded its DS3 link to Ameritech to two OC-3s (primarily for commodity Internet traffic); France Telecom assigned its former 45Mbps DS-3 link to Renater/PHYnet. Despite a provisioning freeze, Kevin Peterson (AADS) configured new VCs for ESnet, PHYnet, Abilene, vBNS and 6TAP. Renater hopes to upgrade to a 155Mbps OC-3c circuit in February/March 2001.

PHYnet will use about 30 Mbps of the traffic, leaving the remaining bandwidth for Renater. There is an urgent need to deliver 30 Mbps sustained capacity between SLAC (in Stanford) and IN2P3 in Lyon for BABAR experiments; Renater has other usage requirements, such as 6TAP and other existing projects. Note: PHYNET is France's High-Energy Physics community network; it is a VPM tailored onto the RENATER infrastructure. PHYnet peers with ESnet in order to connect to SLAC, Fermilab, CERN, etc.

A.1.e. SURFnet

Jason Leigh, in network performance studies with SARA in The Netherlands, is getting 35Mbps throughput over SURFnet's 155Mbps link to STAR TAP. Linda Winkler has been helping solve this puzzle, but it is, unfortunately, still a puzzle.

Meanwhile, SURFnet is interested in upgrading their link to STAR TAP to 622Mbps, and is putting out a Call for Proposal for a transatlantic lambda; i.e., multi-gigabit global connectivity. (Note: On December 8, the Publications Office of European Communities published SURFnet's Call for Proposal announcement; interested bidders should contact <admin@gigasurf.nl> or (phone) +31 30 2305305. SURFnet will connect to the optical STAR TAP, or Star Light, where we are working with Joe Mambretti to arrange co-location space at Northwestern University's Chicago campus, 710 N. Lake Shore Drive.

A.2. Engineering Services

A.2.a. International Transit Network (ITN)

CANARIE ITN and Abilene ITN are new services offered by CANARIE and Internet2 to facilitate connectivity among international National Research Networks (NRNs) that now connect to one of the coasts of North America. We will soon update the STAR TAP web page with information and pointers to the CANARIE and Internet2 web pages that contain more information.

A.2.b. STAR TAP Router Peering

A current list of STAR TAP peers is available on the STAR TAP site at [http://www.startap.net/ENGINEERING/].

A.2.c. 6TAP

No updates at this time.

A.2.d. STAR TAP NLANR Web Cache

Duane Wessels has prepared a replacement machine, now undergoing final testing at EVL before its installation at AADS.

A.2.e. DiffServ

DiffServ experiments between EVL and Argonne National Laboratory have been completed. One major finding is that while DiffServ is able to provide bandwidth guarantees to applications, it is unable to provide latency recovery. A report is being drafted for submission to a journal.
See http://www.evl.uic.edu/cavern/EMERGE/ and http://www.icair.org/inet2000

A.3. NOC Services

On November 5-7, Ameritech Advanced Data Services (AADS) and SBC Advanced Services Inc. (ASI) performed a software upgrade on its NAP ATM network causing all STAR TAP peers to lose connectivity. All peering was reestablished November 7. The NOC reported that Ameritech was not very forthcoming with information, so it had a hard time keeping users abreast of the situation, especially since this was the weekend of SC'2000 setup, and several of the applications were disabled (see Section A.1.b). Their interactions with AADS has been documented, and will be presented (when we find a sympathetic ear ☹).

The NOC continues to seek permission from STAR TAP peers to gather host router network statistics for a planned STAR TAP animated traffic map. Jim Williams reported that no accurate or useful statistics beyond MRTG graphs could be gathered for Euro-Link without closer cooperation and coordination among Euro-Link NRN members and the NOC.

John Hicks is looking into adapting MIRnet-type traffic graphs for the Euro-Link and TransPAC projects.

The NOC plans to post an edited half-hour streaming video program of iGrid 2000 by mid-November (still pending). [http://www.indiana.edu/~video/igrid2000/home.html#litton]

In early October, the Global NOC launched newly designed Euro-Link and STAR TAP NOC web pages [http://noc.startap.net and http://noc.euro-link.org]. The Global NOC web site ties together all NOC-supported network services [http://globalnoc.iu.edu/]. The Global NOC's new email address is <globalnoc@iu.edu>.

Euro-Link Performance Analysis Tools

A.3.a. Network QoS of Real-Time Multimedia

Design is underway to combine CAVERNsoft's network monitoring and EVL's QoSIMoTo (QoS Internet Monitoring Tool) [www.evl.uic.edu/cavern/qosimoto] visualization, to form an integrated problem solving collaboratory (collaborative laboratory) that supports network management, monitoring, visualization and active testing. The goal is to create the equivalent of the "Microsoft Office" suite, for applications developers, network students and researchers to collectively solve network problems.

A.3.b. Network Monitoring

Jason Leigh contacted NLANR's Basil Irwin to get an alpha release of Web100 software to test over international networks.

EVL is currently developing iCAN, the integrated Collaboratory for Analyzing Networks, which is software to enable several remote network researchers and application developers to collaboratively execute an application and monitor network utilization and other application-specific parameters. This will allow them to correlate, in real time, how the actions taken by an application directly impact the underlying networks, and vice-versa. The network researcher may also alter router configurations, such as a router's queuing algorithm, to determine how it may

improve application throughput. Estimated completion of a usable version is end of Spring 2001. The prototype currently allows users to initiate bandwidth measurement experiments and perform SNMP queries of routers.

A.3.c. Low Latency State Transmission Over Long Distance Networks

In the area of high-throughput networking, Jason Leigh has performed experiments using CAVERNsoft's parallel socket library between EVL and SARA, and EVL and CERN. Parallel sockets performed extremely well in maximizing bandwidth utilization. He also found that overuse of parallel sockets did not have a significant detriment on throughput. We are now examining a network bottleneck between EVL and SARA that is limiting TCP bandwidth to 32Mbps over the 155Mbps link (see Section A.1.e).

Leigh has also begun work on a ***Reliable Blast UDP (RUDP)*** transmission scheme designed to accelerate reliable data transmission over fat networks. Caltech's Harvey Newman has expressed interest in employing this technology. In Reliable Blast UDP, the sender blasts all the data (each packet is identified by a sequence number) to the receiver. Upon receipt, the sequence numbers are checked, and any lost packets identified. The receiver then sends a lost packet report back to the sender through TCP. Upon receipt of the report, the sender retransmits the lost packets. The procedure continues until the receiver receives all packets. This technique is believed to be most effective when used in conjunction with QoS, since the guaranteed bandwidth will minimize transmission errors. The RUDP scheme exploits low transmission errors to maximize throughput.

The first results of the new Reliable Blast UDP scheme have been gathered and are encouraging. The student doing the tests, reports that from EVL to SARA (in Netherlands), we got 3.5Mbps using FTP, 35Mbps using parallel TCP, and 75Mbps effective bandwidth using Reliable UDP when the data size is 100MB. A more thorough analysis of the data is underway.

B. Accomplishments

B.1. Euro-Link Applications

Active US/European collaborations utilizing high-performance research networks have been documented for CERN, IUCC, Renater2, SURFnet and NORDUnet, and appear at [http://www.euro-link.org/APPLICATIONS/].

A two-day, major tele-immersive VR demonstration took place between Israel, SARA (Amsterdam), SC'2000 (Dallas) and EVL (Chicago), November 8-9.

B.2. Meetings

B.2.a. November Meetings

November 27-29, 2000. Tom DeFanti and Maxine Brown attended CANARIE's 6th Advanced Networks Workshop entitled: "The Networked Nation." Steve Goldstein of NSF, Linda Winkler of Argonne, Joe Mambretti of Northwestern University, Kees Neggers of SURFnet and Peter Villemoes of NORDUnet attended, as did the host, Bill St. Arnaud.

- We discussed optical STAR TAP (Star Light).
- DeFanti gave a presentation "Star Light: Applications-Oriented Optical Wavelength Switching for the Global Grid at STAR TAP."
- The day before the conference started, DeFanti also gave a lecture at the 3rd meeting of the Canadian Working Group on Virtualized Reality at McGill University, entitled "3D Telephony: Virtual Reality and the Ten Gigabit Telephone Call."
- DeFanti, Brown, Mambretti and Goldstein also met with Yves Poppe of Teleglobe to talk about future STAR TAP plans.
- DeFanti, Winkler, Mambretti and Neggers met with representatives of Level3 about transatlantic wavelengths.
- DeFanti, Brown, Winkler, Mambretti and Goldstein met with Joerg Micheel, WAND and NLANR MOAT, The University of Waikato, New Zealand, about developing Passive Monitoring Analysis (PMA) boxes for wavelengths; Hans-Werner Braun subsequently expressed enthusiastic interest.
- DeFanti, Brown, Winkler, Mambretti and Goldstein met with Brian Pratt, edgeflow Inc., Canada, about their products based on OBGP and STAR TAP's (specifically Star Light's) potential interest.

November 21, 2000. Networking personnel from STAR TAP, AADS, Argonne, MREN and UIC met at EVL to resume discussion of I-WIRE, fiber co-location and Star Light configuration specifications. Ameritech fiber loans in Chicago are progressing up the chain of command at SBC. Joe Mambretti is in charge of negotiations. Charlie Catlett continues to work on I-WIRE fiber. Co-location issues persist; considering alternative co-lo spaces. Discussion of procuring/adding to Cisco 6509s properly configured for NU, UIC Goldberg and EVL, the Star Light co-lo facility and Argonne.

November 17, 2000. John Jamison (JJ) of Juniper Networks gave a presentation at UIC/EVL to representatives from UIC, NCSA, Argonne and Northwestern on MPLS.

November 16-17, 2000. Tom DeFanti, UIC, was keynote speaker at a symposium celebrating the 25th anniversary of the Fraunhofer-Institut fuer Graphische Datenverarbeitung in Darmstadt, Germany. His presentation was entitled "3D Telephony: Virtual Reality and the Ten Gigabit Telephone Call."

November 6-9, 2000. SC'2000, attended by Maxine Brown, Alan Verlo, Chris Scharver and Eric He (UIC), and Linda Winkler (ANL). Tele-immersive demonstrations were run between Israel and Chicago (see A.1.b); also a real-time demonstration by UIC's Bob Grossman with Europe and Australia. Talks about SC Global, to be held at SC'2001 in Denver, November 10-16, 2001, to link Denver with dozens of SC constellation sites distributed throughout the world, all of which support the Access Grid real-time, Internet-based videoconferencing system.

November 2, 2000. Networking personnel from STAR TAP, AADS, Argonne, MREN and UIC met at EVL to discuss I-WIRE, fiber co-location space possibilities and configuration specifications for Optical STAR TAP (Star Light). ANL's Charlie Catlett is working on securing I-WIRE fiber bids and UIC's Will Marcyniuk (UIC) is exploring a possible Cisco donation. SBC/Ameritech, who is donating fiber, wants to be designated as "official" administrative operators of endpoints.

B.2.b. Future Meetings

January 2001. Discussions are underway about the Joint Techs conference in Hawaii, sponsored by NLANR/Internet2/APAN/TransPAC. A BOF session on NOC services and interaction between engineering staffs, is tentatively planned. Invited participants are the Global NOC, APAN, and CA*net3.

December 13. IU will host a STAR TAP/Euro-Link/TransPAC engineering meeting. Issues will include the budding International Transit Network, and other projects involving STAR TAP, CA*net3, and the Global NOC.

December 12-13. John Jamison and Steve Peck have organized a Juniper Networks-sponsored JUNOS class at IUPUI. Juniper's training group manager Matt Kolon will teach a seminar the first day, and dedicate the second to routers. Networking personnel from STAR TAP, IU, CA*net3, and Pittsburgh Supercomputing Center are invited.

B.3. Publications

Y. Zhou, T. Murata, T. DeFanti, and H. Zhang, "Fuzzy-Timing Petri Net Modeling and Simulation of a Networked Virtual Environment – NICE," Institute of Electronics, Information and Communication Engineers (IEICE) Transactions, Fundamentals, Special Section on Concurrent Systems Technology, Vol. E83-A, No. 11, November 2000. [http://www.euro-link.org/PUBLICATIONS/FuzzyTiming_IEICE_Murata_June00.pdf]

B.4. Software Releases

CAVERNsoft G2, version 1.2 was released in time for the October 17-19 CAVERNUS workshop at Old Dominion University (broadcasted over the Access Grid). [http://www.evl.uic.edu/cavern/cavernG2/]. CAVERNsoft is an open source C++ toolkit for building collaborative, networked VR applications. The new version offers the following features:

- Graphical modules now all work under Linux as well, with Linux version of Performer. All other modules work in Windows, IRIX, Solaris, Linux and FreeBSD
- Inverse kinematic articulated avatars with two-arm support (provided the user has an additional tracker)
- Update of coanim (collaborative animator/flip-book program) and LIMBO (application shell) with new inverse kinematic articulated avatars
- Bug fixes to networking modules

- Remote File IO classes with the ability to read the contents of remote directory trees
- CAVERNsoft Database class now supports UDP data reflection as well as TCP
- Performance monitoring added to the parallel TCP classes
- TCP client class provides setsockopt to give more user control of underlying networks
- The networking module can be downloaded separately from higher level graphical modules so that updates can progress independently of each other.

The following features, to be added, are now in the testing phase; details at
http://www.evl.uic.edu/cavern/cavernG2/changes.html

- Generic network-aware Performer manipulators to make shared object manipulation easier to code. Provides both scale, rotate and translate support.
- Performer background file loader - downloads models off remote sites and loads them into a Performer scene graph in the background.
- TIDE 2 will ultimately replace the collaborative flipbook animator (coanim), and CAVERNsoft will run on a Linux cluster (future goal)

QoSIMoTo (QoS Internet Monitoring Tool) [www.evl.uic.edu/cavern/qosimoto] is available on the web for IRIX and Linux.

C. Collaboration Activities

- Working with SARA in The Netherlands to experiment with an EVL-designed packet-level Forward Error Correction scheme.
- Working with Harvey Newman at Caltech and Olivier Martin at CERN on DiffServ tests.
- Working with Hank Nussbacher and associates at the Technion University on Telecom 2000.

D. Summary of Award Expenditures (November)

Spending is within budget.